

# Vehicle and Engine Technology

## Second Edition

**Heinz Heisler**

MSc, BSc, FIMI, MIRTE, MCIT

Formerly Principal Lecturer and Head of  
Transport Studies,

College of North West London,

Willesden Centre,

London, UK

**B**UTTERWORTH  
**H**EINEMANN

OXFORD AUCKLAND BOSTON JOHANNESBURG MELBOURNE NEW DELHI



# Contents

<i>Preface to the first edition</i>	xii	4.6	Four-speed and reverse transaxle automatic transmission mechanical power flow (Nissan Primera)	82
<i>Preface to the second edition</i>	xiii	4.7	Hydraulic automatic gear change control system	89
<b>1 Vehicle body and chassis layout</b>	<b>1</b>	4.8	A four-speed and reverse simplified hydraulic control system	95
1.1 The motor car	1	<b>5 Propeller shafts, universal joints and constant velocity joints</b>	<b>102</b>	
1.2 Commercial vehicles	3	5.1 Propeller shaft	102	
1.3 Chassis construction	9	5.2 Hooke's universal joint	102	
1.4 Vehicle components and their methods of attachment and location	13	5.3 Universal-joint needle-bearing lubrication	104	
1.5 Comparison of major component layouts	15	5.4 Propeller-shaft slip-joint	106	
1.6 Seat location and securing	20	5.5 Series-coupled universal joints	108	
1.7 Seat-belt location, fitting points and operation	22	5.6 Propeller-shaft vibration	109	
1.8 Jacks and jacking points	24	5.7 Divided propeller shafts and their support	111	
<b>2 The friction clutch</b>	<b>28</b>	5.8 Universal- and slip-joint alignment	113	
2.1 The purpose of a clutch	28	5.9 Constant velocity joints	114	
2.2 Description and operation of a multi-coil spring clutch unit	30	5.10 Rubber universal couplings	115	
2.3 Cushioned driven-plate with torsional vibration damper	36	<b>6 The final drive and four-wheel drive</b>	<b>118</b>	
2.4 Clutch operating linkage	36	6.1 The purpose of the final-drive gears	118	
2.5 Clutch faults, causes and remedies	40	6.2 Types of final-drive gearing	120	
<b>3 Gearbox construction and operation</b>	<b>42</b>	6.3 The need for final-drive differential gearing	124	
3.1 The purpose of the gearbox	42	6.4 Rear-axle half-shaft and hub arrangements	130	
3.2 Four-speed sliding-mesh and constant-mesh gearboxes	47	6.5 Differential lock	133	
3.3 Rod-and-fork gear selectors	53	6.6 Four-wheel drive	133	
3.4 Spring-loaded ball or plunger and selector-rod grooves	54	<b>7 Suspension, road-wheels and tyres</b>	<b>141</b>	
3.5 The need for a gear interlocking device	55	7.1 Semi-elliptic leaf springs	141	
3.6 Positive baulk-ring synchromesh unit	58	7.2 Rigid-axle-beam suspension	148	
3.7 Gearbox lubrication	62	7.3 Independent front suspension	152	
3.8 Gearbox oil-leakage prevention	64	7.4 Benefits and limitations of independent front suspension	158	
<b>4 Automatic transmission</b>	<b>66</b>	7.5 Construction and action of independent front suspension	159	
4.1 Hydrokinetic fluid coupling	66	7.6 Antiroll bars	163	
4.2 Hydrokinetic torque converter-coupling	70	7.7 Telescopic-shock-absorber damper	166	
4.3 Sprag-type free-wheel one-way clutch	71	7.8 Rear suspension	168	
4.4 Torque converter lock-up clutch	73	7.9 Axle beam non-drive rear suspension	168	
4.5 Epicycle gear train	73	7.10 Rear independent suspension	171	



7.11	Tandem axle leaf spring suspension	173	10.3	Four-stroke-cycle-compression-ignition (diesel) engine	300
7.12	Rubber spring mounted on a balance-beam with leading and trailing torque-rod suspension	176	10.4	Two-stroke-cycle diesel engine	302
7.13	Air spring suspension	177	10.5	Comparison of spark-ignition and compression-ignition engines	305
7.14	Road-wheels	179	10.6	Engine-performance terminology	305
7.15	Pneumatic-tyre construction	185	10.7	Compression-ratio	307
7.16	Legal and technical requirements when using cross- and radial-ply tyres	192	<b>11</b>	<b>Multi-cylinder engine arrangements</b>	<b>309</b>
7.17	Tyre sizes and designations	193	11.1	The need for more than one cylinder	309
7.18	Tyre valves	194	11.2	Cyclic torque and speed fluctuation	310
7.19	Safety precautions in tyre maintenance	196	11.3	Merits and limitations of single- and multi-cylinder engines	311
7.20	Tyre inflation pressure	197	11.4	Cylinder firing orders	313
7.21	Wheel balance	197	11.5	Single-cylinder arrangement	313
<b>8</b>	<b>Steering systems</b>	<b>203</b>	11.6	In-line side-by-side twin-cylinder arrangement	314
8.1	Steering linkage arrangements	203	11.7	In-line 180°-out-of-phase twin-cylinder arrangement	314
8.2	The Ackermann principle as applied to steering linkage	209	11.8	Horizontally opposed twin-cylinder arrangement	315
8.3	The need for front-wheel alignment	213	11.9	In-line three-cylinder arrangement	315
8.4	Front-wheel toe-in or toe-out	214	11.10	In-line four-cylinder arrangement	316
8.5	Track alignment and adjustment	215	11.11	Horizontally opposed flat four-cylinder arrangement	317
8.6	Rack-and-pinion steering assembly	219	11.12	In-line five-cylinder arrangement	318
8.7	Steering gearbox	222	11.13	In-line six-cylinder arrangement	319
8.8	Front-wheel bearing-hub assembly	223	11.14	Horizontally opposed flat six-cylinder arrangement	320
8.9	Independent suspension front-wheel drive hub and swivel-pin carrier assembly	226	11.15	In-line straight eight-cylinder arrangement	321
8.10	Power-assisted steering	226	11.16	90° 'V' twin-cylinder arrangement	322
<b>9</b>	<b>Brake systems</b>	<b>235</b>	11.17	60° 'V' four-cylinder arrangement	323
9.1	Single-line hydraulic braking system	235	11.18	60° 'V' six-cylinder arrangement	324
9.2	Leading-and-trailing-shoe layout	237	11.19	90° 'V-eight' with single-plane crankshaft	325
9.3	Cam-operated drum-brakes	239	11.20	90° 'V-eight' with two-plane or cruciform crankshaft	326
9.4	Wheel-cylinder shoe-expanders	241	<b>12</b>	<b>Balancing of reciprocating components</b>	<b>328</b>
9.5	Wedge-operated shoe-expander units	245	12.1	Reciprocating motion	328
9.6	Shoe-adjusters	248	12.2	Four-cylinder chain drive parallel twin countershaft secondary force balancer	335
9.7	Hand-brake linkage and mechanisms	251	12.3	Torsional crankshaft vibration	335
9.8	Disc and pad brakes	254	12.4	Force imposed on the piston	339
9.9	Brake master-cylinders	257	12.5	Journal bearing load considerations	341
9.10	Brake bleeding	268	12.6	Engine and gearbox mountings	343
9.11	Vacuum-assisted brake servo-unit	268	<b>13</b>	<b>Cylinder block and head construction</b>	<b>349</b>
9.12	Antilocking brake system (ABS) (Alfred-Teves)	271	13.1	The cylinder block	349
9.13	Air-operated power brakes	276	13.2	The crankcase	352
9.14	Foundation brake and single-diaphragm wheel brake actuator	280			
9.15	Exhaust compression brake retarder	289			
<b>10</b>	<b>Piston-engine cycles of operation</b>	<b>292</b>			
10.1	The internal-combustion engine	292			
10.2	The two-stroke-cycle petrol engine	296			

13.3	Camshaft location and support	353	17	<b>Valve timing diagrams, cam design and camshaft drives</b>	<b>425</b>
13.4	Cylinder-block materials	353	17.1	Inlet and exhaust valve opening and closing periods	425
13.5	The cylinder head	355	17.2	Cam profile phases and valve opening and closing periods	427
13.6	Cylinder-head materials	356	17.3	Variable valve lift and timing control	429
13.7	Stud and set-screw threaded cylinder-block holes	357	17.4	Camshaft chain-belt and gear train drives	433
13.8	The tightening-down of cylinder heads	358	<b>18</b>	<b>Poppet-valve operating mechanisms</b>	<b>442</b>
13.9	Cylinder-head gaskets	363	18.1	The function of the valves and their arrangements	442
13.10	Crankcase sump and baffle plates	366	18.2	Side camshaft with push-rod and rockers	442
13.11	Cylinder-bore liners	367	18.3	Tappet clearance adjustment for push-rod mechanisms	447
13.12	Dry cylinder liners	367	18.4	Overhead camshaft (OHC)	448
13.13	Wet cylinder liners	369	18.5	Tappet adjustment for direct-acting mechanisms	451
13.14	Removal and replacement of press-fit liners	371	18.6	Valve-actuating-gear requirements and considerations	452
<b>14</b>	<b>Combustion and combustion chamber design</b>	<b>373</b>	18.7	Advantages and disadvantages of the various valve mechanisms	453
14.1	Spark ignition combustion process	373	18.8	The poppet-valve	454
14.2	Compression ignition (diesel) combustion process	385	18.9	Poppet-valve operating conditions	455
<b>15</b>	<b>Piston and connecting-rod assemblies</b>	<b>390</b>	18.10	Poppet-valve materials	456
15.1	Friction and heat distribution of the piston assembly	390	18.11	Valve guides	457
15.2	Piston materials	390	18.12	Valve-seat insert rings	458
15.3	Piston nomenclature and design considerations	392	18.13	Valve-spring retention	459
15.4	Bi-metal strut position	395	18.14	Valve-rotators and spring retention	459
15.5	Piston-ring nomenclature	397	18.15	Valve compression return-springs	461
15.6	Piston-ring action	398	18.16	Automatic tappet clearance adjustment via a hydraulic element	463
15.7	Piston-ring materials and methods of manufacture	401	<b>19</b>	<b>Engine lubrication system</b>	<b>469</b>
15.8	Piston and piston-ring working clearances	402	19.1	Wet-sump lubrication system	470
15.9	Piston and connecting-rod gudgeon-pin joints	404	19.2	The mechanics of friction and lubrication	480
15.10	Connecting-rod design, construction and materials	406	19.3	High-pressure oil-pumps	484
15.11	Connecting-rod shell liner bearings	408	19.4	Pressure-relief-valve control	489
15.12	Plain journal bearings	412	19.5	Oil filtration	491
<b>16</b>	<b>Crankshaft construction</b>	<b>414</b>	19.6	Engine oil-leakage prevention	493
16.1	Crankshaft nomenclature	414	19.7	Dry sump lubrication system with liquid-to-liquid oil cooler	498
16.2	Crankshaft proportions	415	19.8	Crankcase emission control	499
16.3	Counterbalance weights	416	19.9	Low oil pressure switch and warning light circuit	500
16.4	Crankshaft oil-hole drillings	416	19.10	Properties and selection of engine lubricants	501
16.5	Fan-belt pulley-to-crankshaft attachment	417	19.11	Correct maintenance of oil level	504
16.6	Front and rear crankshaft oil-seals	418	19.12	Oil contamination and replacement intervals	505
16.7	Flywheel-to-crankshaft attachment	419			
16.8	Crankshaft materials and heat treatments	419			
16.9	Crankshaft main-journal bearings	422			

<b>20</b>	<b>Cooling systems</b>	<b>506</b>	<b>23</b>	<b>Diesel-engine fuel injection systems</b>	<b>582</b>
20.1	Engine heat distribution and the necessity for a cooling system	506	23.1	Layout of a diesel-engine fuel system	582
20.2	Types of cooling systems	507	23.2	Plunger-type fuel lift pump	585
20.3	Heat transfer in an indirect liquid-cooled engine system	509	23.3	In-line injection pump (CAV 'Minimec')	585
20.4	Comparison of air- and liquid-cooling systems	514	23.4	Distributor-type injection pump (CAV 'DPA')	590
20.5	Thermostat-controlled cooling systems	515	23.5	Injector unit	592
20.6	Pressure radiator caps	517	23.6	Electronically controlled unit pump-injector diesel fuel injection system	595
20.7	Cooling systems incorporating an expansion tank	520	23.7	Electronically controlled unit pump diesel injection system	596
20.8	Antifreeze coolant solutions	521	23.8	Electronically controlled unit common-rail diesel injection system	598
20.9	Engine core plugs	524	23.9	Cold start starting aids	600
20.10	Maintenance requirements of the cooling system and components	525	23.10	Diesel-fuel filtration	603
20.11	Cross-flow cooling system with liquid-to-liquid oil cooler	525	23.11	Air-intake silencers and cleaners	606
20.12	Air temperature sensing viscous fan coupling	527	<b>24</b>	<b>Induction/exhaust manifold-exhaust silencer and emission control</b>	<b>610</b>
20.13	Cooling fan relay and thermal switch circuit	529	24.1	Induction wave ram cylinder charging	610
20.14	Interior heating and ventilating system	530	24.2	Supercharging	613
20.15	Air conditioning	531	24.3	Exhaust manifold configurations	622
<b>21</b>	<b>Petrol-engine carburation fuel system</b>	<b>539</b>	24.4	Exhaust gas emission control	624
21.1	Layout of a petrol-engine fuel system	539	24.5	Exhaust gas silencers (mufflers)	627
21.2	Petrol feed pumps	540	24.6	Fuel tank evaporation control	635
21.3	Carburation	544	24.7	Air intake temperature control	637
21.4	Constant choke single-barrel carburettor	553	24.8	Exhaust gas recirculation	638
21.5	Compound-barrel differentially operated carburettor	555	24.9	Air injected exhaust system	639
21.6	Constant-pressure or vacuum variable-choke carburettor	557	<b>25</b>	<b>Electrical wiring and lighting</b>	<b>641</b>
21.7	Attitude of the choke tube	559	25.1	Electron theory	641
21.8	Induction and exhaust manifolds	559	25.2	Electrical units	642
21.9	Multi-carburettors	560	25.3	Basic vehicle wiring circuits	644
21.10	Air-intake silencers and cleaners	561	25.4	Cables	647
<b>22</b>	<b>Petrol engine fuel injection systems</b>	<b>563</b>	25.5	Cable colour code	649
22.1	Comparison of the various fuel supply systems	563	25.6	Cable connectors	650
22.2	Bosch KE-Jetronic multipoint petrol injection system	563	25.7	Printed circuits	654
22.3	Multipoint electronic petrol injection	567	25.8	Fuses	655
22.4	Single-point electronic petrol injection system	576	25.9	Light-bulb fundamentals	656
22.5	An introduction to the electronic control unit	578	25.10	Headlight reflectors	657
			25.11	Headlight arrangements	659
			25.12	Headlight cover lens	660
			25.13	Classification of light-bulbs	661
			25.14	Tungsten-halogen light-bulbs	663
			25.15	Light-bulb location and attachments	663
			25.16	Four-headlight system	665
			25.17	Headlight settings	665

<b>26</b>	<b>Coil ignition system</b>	<b>667</b>	<b>27</b>	<b>Batteries, generators and starter motors</b>	<b>694</b>
26.1	Ignition considerations	667	27.1	The lead-acid battery	694
26.2	Ignition-system equipment	667	27.2	Generators	700
26.3	Fundamental electromagnetism definitions	668	27.3	Alternators	700
26.4	Ignition-coil construction	669	27.4	Voltage regulator	713
26.5	Capacitor function and operation	672	27.5	Dynamos	715
26.6	Distributor contact-breaker construction	673	27.6	Starter motors	719
26.7	Mechanical centrifugal advance device	674	<b>28</b>	<b>Electrical auxiliary equipment</b>	<b>731</b>
26.8	Manifold vacuum advance device	678	28.1	Instrument panel gauges and transmitter senders	731
26.9	Ignition timing	680	28.2	Direction indicators	743
26.10	Spark-plug function	682	28.3	Windscreen wiper systems	746
26.11	Transistors	684	28.4	Power window winders	757
26.12	Electronic ignition control	685	28.5	Central door locking	762
			<i>Index</i>		767

# Index

- abutment bracket, 151
- ABS control cycle characteristics, 275
- accumulator, 95
- Ackerman linkage, 210
  - linkage geometry, 212-13
  - modified linkage, 212
  - principle, 209
- addendum, 45
- aftercooling (intercooling), 621
- after-burn period (combustion), 373, 386
- A-frame, 169
- Akroyd-Stuart (Herbert), 302
- air and petrol mixture strength, 544
- air conditioning, 531-2
- air-cleaner-condition of service and control, 561
  - paper element dry air cleaner, 561-2
- air-core cross-coil gauge, 740-2
  - fuel level gauge, 742
  - coolant temperature, 742
- air-intake silencer and cleaners, 561-2, 606-9
- air intake temperature control, 637-8
- air injected exhaust system, 639-4
- air-operated power brakes, 276
- air spring suspension, 177-80
- alternators
  - charging system checks, 714-15
  - circuit rectification, 703
  - construction, 701-2
  - cylindrical yoke, 704, 706
  - design considerations, 708
  - field winding excitation, 706, 708, 712
  - generating an alternating voltage and current, 701, 703
  - principle of operation, 700-1
  - single phase bridge circuit full-wave rectification, 704
  - warning light circuit checks, 714
- Alumina, 626
- Aluminised low carbon steel pipes and silencers, 633
- Aluminium atom, 641
- Aluminium-base bearing alloy, 413
- ampere, 643
- ampere-hour discharge rate, 699
- angular torque gauge, 362
- annular gear, 44
- antiback-fire prevention by-pass valve, 640
- anti-dribble action, 589
- antilocking brake system (ABS), 271-5
- anti foaming agents, 504
- antiroll-bars, 163, 165
- anti-wear agents, 504
- armature, 715, 719
- articulated tractor, 7
- aspect ratio, 181
- automatic chain tensioners, 435-6
- automatic gear change control, 89-91
- automatic ignition advance, 647-80
- automatic transmission, 66
- atom, 641
- axial (sliding armature) type starter motor, 725-74
- axis of oscillation, 343
- axle-beam, 4
  - axle tramp, 149
  - construction and action, 148
  - bump and rebound, 149
  - bump stops, 149
  - reasons for using beam type axle, 149
  - suspension, 148
  - 'U' bolts, 148-9
  - axle-tube, 148
- axle-hub
  - fully floating, 132
  - semi-floating, 130
  - three quarter floating, 131
- axle beam non-drive rear suspension, 168
- antifreeze coolant solution, 521-4
  - corrosion inhibitors, 523
  - desirable properties, 523
  - ethylene glycol, 523, 524
  - measuring solution strength, 523-4
  - water suitability, 522-3
- back emf and constant speed motor, 750
- batteries, 694
- battery chargers, 697
- battery-care and maintenance, 699
  - installation, 699, 670
  - mixing electrolyte, 700
  - personal safety precautions, 700
  - terminal corrosion, 700
  - topping up, 699
- balancing of reciprocating components, 328
- band brake, 45, 90
- band brake servo, 90-3, 97-101
- barrel roll swirl, 376
- bath tub combustion chamber, 379
- basic vehicle wiring circuits, 644
- baulking ring, 60-2
- bearing lubrication (stub axle), 223
- Belleville dished-washer-spring, 36
- Belleville washer spring, 32
- bell-housing (clutch), 15
- bellows type thermostat, 515

- belt camshaft drive, 433, 438-40
- bending stiffness, 11
- bevel differential gearing, 126
- bevel gear third differential, 137
- bevel pinion, 120-2
- big-end, 293
- big-end (crankpin) journals, 415
- big-end cap tightness, 411
- big-end lubrication, 471
- bi-metal thermal coolant temperature gauge, 735, 737
- bi-metal thermal fuel gauge, 737-8
- blower (air-conditioning), 532, 536
- boiling point of water, 518
- boost pressure control, 621
- boundary lubrication, 482
- Bosch KE Jetronic multi-point petrol injection system, 563-7
- Birfield constant velocity joint, 114
- Binney (R Charles), 302
- body roll, 164
- body roll stability, 178
- bolted joint, 13
- bottom dead centre (BDC), 293
- brakes, 14, 235
  - air assisted hand parking brake, 278
  - air-operated power brakes, 276
  - antilocking brake system (ABS), 271-5
  - cam-operated drum brakes, 239
  - compressed air supply, 277-8
  - compressor, 276
  - differential protection valve, 288-90
  - disc brakes, 254-7
  - double floating-piston-caliper assembly, 255
  - drums, 239
  - equaliser, 251-2
  - exhaust retarder, 289-91
  - foot control valve, 282-5
  - foundation brake, 280-1
  - hand control valve, 284-5
  - line bleeding, 268
  - linings, 259
  - load sensing progressive pressure limiting valve, 266-8
  - master cylinders, 258
  - pipes, 235
  - quick release valve, 287-8
  - relay valve, 285, 287
  - shoes, 239
  - shoes adjustments, 248-51
  - shoes double piston expanders, 242
  - shoe combined hydraulic lever expander, 243
  - shoe combined hydraulic wedge expander, 246
  - shoe push-type wedge expander, 248
  - shoe pull-type wedge expander, 247
  - sliding-pin type disc caliper, 256-7
  - shoes single piston expanders, 244
  - slack adjuster, 280-2
  - spring brake actuator, 280-3
  - swing link compensator, 252-3
  - tandem master cylinder, 264-6
  - truck air-over-hydraulic brake system, 276-7
  - truck three line brake system, 277-8
  - truck two line brake system, 278
  - vacuum assisted servo unit, 268-71
  - unloader valve (pressure regulator), 282-4
  - wheel actuator, 280-1
- brake power (bp), 307
- Bromine, 663
- bump stop, 148-9
- bump stops and spring aids, 165-6
- by-pass flow oil filter, 493
- caliper-plate interlocking device, 56
- cam-follower materials, 444
- camshaft, 442
- camshaft
  - chain drive, 433-4
  - chain, belt and gear train drives, 433
- camshaft-cam design, 427
  - location and support, 353-4
  - materials, 443
  - side mounted shaft with push-rod rockers, 442
- cam
  - acceleration and deceleration, 427
  - crash noise, 427
  - flank, 427-8
  - follower (tappet), 444-5
  - lobe, 427-8
  - nose, 427-8
  - profile, 427-8
  - point of inflection, 427-8
  - ramp, 427
  - tappet clearance, 427
  - cantilever mounted semi-elliptic spring, 142
- cables, 647
  - cable colour code, 649-52
  - cable specifications, 647-9
  - connectors, 650-3
  - ignition H.T. cable, 649
  - power capacity of a cable, 647
- capacitor, 672-3
  - carbon atom, 641
  - carbon dioxide, 624
  - carbon monoxide, 624
  - carburation, 544
- carburettor
  - air-bleed and capacity well compensation, 550
  - air-screw control, 551-2
  - butterfly throttle valve, 546
  - capacity-well compensation, 549
  - constant choke single barrel carburettor, 553
  - diaphragm operated acceleration pump, 555, 557
  - diaphragm operated power valve, 555-6
  - differentially operated secondary stage throttle linkage, 555
  - float chamber, 548
  - float chamber needle valve, 548
  - idle running conditions, 551

- idle and progression system, 553, 555-6
- limitation of single-jet carburettor, 549
- main mixture correction control system, 553-6
- parallel tube, 544-5
- piston operated acceleration pump, 553-4
- piston operated power valve, 553-4
- progressive duct, 552
- single-jet fixed choke, 546
- strangler (choke) butterfly valve, 551, 553
- venturi depression, 547
- venturi-tube (choke), 545
- volume screw control, 551-2
- Cardan (Jerome), 103
- castor angle, 155-7
- catch bar (door locks), 762
- central differential (third differential), 139
- central lock doors, 762
  - actuator circuit, 763-5
  - centre point and semi-centre point steering, 155
  - circuit breaker, 763
  - cylindrical key lock, 764-5
  - dual-polarity motor, 763
  - twin relays, 764-5
- chain camshaft drive, 433
- circuit breaker
  - central door lock, 763
  - power windows, 759, 761
- claw pole, 704, 706, 708
- claw-plate and bar-type door lock, 762
- claw-plate latch, 762
- closed deck, 353
- co-axial (sliding-pinion) type starter motor, 727-9
- coolant
  - circulation pump, 511-13
  - jackets, 511, 351-2
  - pump operation, 512-13
  - pump faults, 514
  - pump impeller-spindle seal, 512-13
- cooling fan relay and thermostat switch circuit, 529-30
- cooling system, 506
  - air-cooling, 507-9
  - conduction, 507
  - convection, 507
  - core plugs, 524-5
    - cup, 525
    - screw, 525
    - welch, 524
  - corrosion inhibitors, 523
  - 'crack' temperature (thermostat), 515
  - cross flow radiator, 514-15
  - heat distribution, 506
  - heat transfer in a direct air-cooled engine, 508
  - heat transfer in an indirect liquid-cooled engine, 509-10
  - heat transfer
    - conduction, 507
    - convection, 507
    - radiation, 507
  - oil cooler, 514-15
  - maintenance, 525
  - method of heat transfer, 506
  - operating temperature conditions of the engine, 506
  - pressurised, 517-20
  - radiation, 507
  - thermostat and by-pass flow control, 514
  - thermostat-controlled, 515-17
- conduction, 507
- constant-mesh gear wheels, 58, 60-1
- constant pressure carburettor
  - air-valve piston action, 557-8
- convection, 507
- cross flow cooling system with liquid to liquid oil cooler, 514-15
- choke-tube attitude
  - up draught, 559
  - down draught, 559
  - horizontal draught, 559
- carrier (epicyclic gear), 44
- catalytic-converter, 626
- Cetane number, 387
- chassis, 4
  - construction, 9
  - sections, 10-11
  - side and cross member joints, 12
  - side and cross member torsional resistance, 12
- circumferential and longitudinal tensile stresses, 349
- closed circuit, 644
- clearance volume, 294
- clutch, 14
  - adjustment, 38-9
  - drag or spin, 41
  - cable, 38
  - cable operated, 38
  - crimped leaf spring segments, 36
  - cushion driven-plate with torsional damper, 36
  - driven-plate wear, 40
  - driven-plate glaze, 40
  - faults, 40
  - fierceness or snatch, 41
  - fundamentals, 28
  - judder, 40
  - shudder, 36
  - slip, 40
- clutch servo unit, 90
- coach, 9
- coefficient of friction, 480-1
- coil ignition system, 667
- cold starting mixture control, 559
- combustion
  - combustion and combustion chamber design, 373
  - combustion-oil contamination, 505
  - controlled and uncontrolled combustion, 374-5
- commercial vehicle, 3
- Commission tecnica di Unificazione nell'Automobile (CUNA)-Italian, 307
- commutation
  - dynamo, 716
  - starter, 720

- comparison of spark-ignition and compression-ignition engine, 305, 389
- comparison of two and four-stroke cycle diesel engines, 304
- comparison of two and four-stroke cycle petrol engines, 299
- compounds, 641
- composite stacked cylinder head block and crankcase, 350-1
- compound-barrel differentially operated carburettor, 555
- compound epicyclic gear train, 79
- compound or multi-stage gear train, 43
- compression ignition (diesel) combustion, 385
- compression ignition engine (diesel) historical background, 302
- compression ratio, 307-8
- compression stroke, 294-5, 300
- compressor (air-conditioning), 532-4
- compressor (wheel), 618-19
- condenser (air conditioning), 534
- conical clutch (synchromesh), 58, 61-2
- connecting-rod, 293, 406-7
  - big-end cap location and retention, 406
  - big-end cap tightness, 411
  - design, 406-8
  - liner-shell bore relief, 411
  - materials, 406
  - roundness of the housing bore, 410-11
  - surface finish, 410
  - shell free spread, 410
  - shell linear bearings, 408-9
  - shell location lug, 410
  - shell-spin prevention, 410
  - stepped cap, 410
- control helix, 588
- constant pressure carburettor
  - air-valve piston action, 557-8
  - mixture correction control, 557-8
  - mixture temperature compensation, 558-9
- constant-pressure or vacuum variable choke carburettor, 557-8
- constant-rate leaf springs, 143
- constant track unequal double transverse-wishbone independent front suspension, 161
- constant velocity joints, 114
- continuously adjusting variable-length induction manifold system, 613
- contact breaker dwell, 673-4
- converter pressure (automatics), 93
- convertible, 1
- copper atom, 641
- coupé, 1
- couples, 329
- coupling speed range (transmission), 71, 73
- crankcase, 352
  - disc-valve and reed-valve inlet charge control, 298
  - emission control, 499
  - sump and baffle plates, 366-7
- crack temperature (thermostat), 515
- crank-throw, 414
- crank-web, 414
- crankshaft, 293
  - carbonitriding surface hardening, 422
  - classification of plain journal bearing materials, 412
  - counter balance weights, 416
  - end float thrust bearings, 422-3
  - flywheel attachment, 419
  - journals, 293
  - journal bearing clearance and measurement, 424
  - main journals, 414, 422
  - materials and heat treatments, 419-22
  - nomenclature, 414
  - oil hole drillings, 416
  - oil seals, 418-19
  - proportions, 415
  - pulley attachment, 417
  - torsional vibration characteristics, 338
- crankshaft to camshaft drive, 433
- cross-coil gauge, 740-2
- cross-ply tyres, 188
- crown-wheel, 120-2
- cyclic torque and speed fluctuation, 310
- cylinder
  - block, 292
  - block and head construction, 349
  - bore, 294
  - bore liners, 367
  - capacity, 307
  - crankcase, 292
  - firing orders, 313
  - head, 292, 355
  - head gaskets, 363-6
  - head valve and port layouts, 355
  - materials, 353-4, 356
- cylindrical bush rubber mount, 347-8
- current, 642
  - generation, 715
  - regulator (dynamo), 718
- cut-out, 7
- Darlington pair transistors, 692-2
- deep-bowl volumetric combustion chamber, 387
- dedendum, 45
- delivery valve action, 589
- detergents, 504
- detent valve, 90-1
- detonation, 374
- Deutsch Industrie Normale (DIN), 307
- diagonal twin tie-rods, 169
- diaphragm clutch load-deflection characteristics, 35
- diaphragm spring clutch, 32
- diaphragm-type
  - lever operated petrol pump, 541-2
  - push-rod operated petrol pump, 541, 543-4
- dibromomethane gas, 663
- differential cage, 126
- differential gearing, 124-8

- differential lock, 133
- differential protection valve, 288-90
- diesel air intake silencers and clearers, 606
  - heavy duty duo-dry air cleaner, 608
  - heavy duty oil bath air cleaner, 609
  - medium duty dry air cleaner, 606-7
  - medium duty oil bath air cleaner, 609
- diesel cold start aids, 600-3
  - manifold heat operated thermostate, 600-1
  - glow-plug, 601-3
- diesel fuel injection system
  - electronic controlled unit common rail, 598-600
  - electronic controlled unit pump, 596-8
  - electronic controlled unit pump-injector, 594-6
- diesel engine
  - fuel system layout, 582-3
  - fuel injection system, 582
- diesel fuel filtration, 603-9
  - abrasive concentration in fuel, 603
  - cold weather wax formation, 604
  - cross flow filters, 604-5
  - filter materials, 604
  - primary filter sedimentor, 605
  - properties of resin impregnated paper filters, 604
  - secondary canister paper filter units, 604
  - secondary filter agglomerator, 606
  - solid particle contamination, 603
  - twin-bowl filters, 606
  - up or down filters, 605
  - water contamination, 604
- diesel knock, 386
- diesel in-line fuel injection pump
  - combined piston and diaphragm type lift pump, 585-6
  - fuel tank, 582-3
  - high pressure pipes, 582-3
  - in-line type injection pump (CAV minmac), 585-6
  - injector unit, 582-3
  - lift pump, 582-3
  - leak-off pipe, 582-3
  - plunger-type fuel lift pump, 584-5
  - pressure relief valve or permanent-bleed orifice, 582-3
  - primary filter, 582
  - secondary filter, 582-3
- diesel injector unit, 592-4
- diesel distributor type fuel injector pump (CAV-DPA), 583, 590
  - cam profile action, 592
  - description and construction of pump unit, 590-1
  - rotor and plunger pumping action, 591
- Diesel (Rudolf), 302
- direction signal indicators, 743
  - electronically controlled unit, 45, 47, 743
  - thermal vane flasher unit, 743-5
- direct injection open combustion chamber, 387
- direct injection quadruple-valve petrol engine, 383-4
- direct injection semi open combustion chamber, 387-8
- disc and pad brakes, 254-7
  - disc brake, 236
  - disc caliper, 255, 257
  - dispersants, 504
  - distributor contact-breaker construction and adjustment, 673-4
  - distributor micrometer adjustment, 680
  - divided propeller shafts and their support, 111
  - dog clutch, 58, 60-2
  - door actuator and latch mechanism, 762-3
  - door lock claw-plate and striker-bar, 762
  - double decker bus, 9
  - double helical gear, 46
  - double inclined wedge rubber mount, 347
  - double piston wheel cylinder expander, 242
  - double planet pinion, 80
  - double-row side valve combustion chamber ('T' head), 337
  - doughnut-type (Roloflex) rubber coupling, 115
  - driven-plate torsional damping, 36
  - drive-shaft, 14
  - drive straps (clutch), 30
  - drag link, 205
  - drag torque, 153
  - drum brake, 236
  - dry cylinder liners, 367
  - dry sump lubrication system, 498
  - dual or split line braking system, 262-4
  - dual-stage induction manifold system, 610-12
  - dual polarity power window motor, 759-61
  - dual polarity central lock actuator motor, 763-4
  - dual pressure switch (air-conditioning), 536
  - dual valve lift and timing, 429-32
  - dynamic and combustion disturbances, 343
  - dynamic oil seals, 495
  - dynamic radial or axial contact seals, 494-7
  - dynamic wheel balance, 200
  - dynamic (regenerative) wiper braking, 752
  - dynamo (generator), 700, 715
    - current control, 718
    - current generation, 715
    - commutation, 716
    - cutout, 716
    - voltage control, 718
  - earth return, 644-5
  - eddy current, 748
  - effects of combined gas and inertia forces on bearing load, 342-4
  - effects of offset gudgeon pin, 341
  - effects of reciprocating inertia forces, 342
  - electrical auxiliary equipment, 731
  - electrical conductor, 642
  - electrical circuit symbols, 647-8
  - electrical wiring and lighting, 641
  - electrical insulator, 642
  - electrical unit, 642
  - electromagnetism, 668
  - electrolyte, 694-7
  - electro-motive-force (e.m.f.), 643

- electron, 641
- electron shells, 641
- electron theory, 641
- elements, 641
- electronic control unit
  - address bus, 579-80
  - an introduction, 678-9
  - control bus, 579-80
  - data bus, 579-80
  - electronic control unit, 578-9
  - input analogue to digital converter (ADC), 578-80
  - input circuit, 579-80
  - input-output circuit, 579-80
  - input processing circuit, 579-80
  - inter-connecting buses, 579-80
  - output amplifier, 579-81
  - output digital to analogue converter (DAC), 579-80
  - output circuit, 579-80
  - memory, 580
  - micro processor, 579
  - power supply, 578-9
  - random access memory (RAM), 579-80
  - read only memory (ROM), 579-80
- electronic controlled unit common-rail diesel injection system, 598
  - electronic control unit, 598
  - high pressure pump, 598-9.
  - unit injector, 600
- electronic controlled unit pump diesel injection system, 596
  - electronic control unit, 596
  - phases of operation, 596-8
- electronic controlled unit pump-injector diesel fuel injection system, 594-6
  - electronic control unit, 595
  - phases of operation, 595-6
- electronic ignition control, 685
- electronically controlled signal indicator, 743, 745, 747
- energising spring, 60, 62
- engagement and disengagement mechanism (clutch), 30
- engine and gearbox mountings, 343
- engine cylinder capacity, 307
- engine lubricants, 501-5
- engine lubrication system, 469
- engine oil-leakage prevention, 493
- engine performance characteristics, 42
- engine power, 306
- engine power unit, 14
- engine torque, 306
- epicyclic compound gear train, 79
- epicyclic differential, 139-40
- epicyclic gears, 44
- epicyclic gear train, 73-9
- epicyclic third differential transfer box, 136
- epicyclic twin planet pinion, 79
- estate car, 2
- evaporator, 534
- exciter brushes, 706
- exciter diodes, 704, 706
- exhaust and inlet valve opening and closing periods, 425
- exhaust compression brake retarder, 289-91
- exhaust gas
  - absorptive chamber silencer, 629, 631-2
  - approach to noise suppression, 627
  - fundamental noise, 627
  - reactive interference silencer, 629-30
  - resonant chamber silencer, 627-8
  - secondary noise, 627
  - silencing of exhaust gases, 627
- exhaust gas composition, 624
- exhaust gas emission control, 624-7
- exhaust gas recirculation (EGR), 638-9
- exhaust manifold configurations, 622
  - in-line four cylinder engine, 622-3
  - in-line five cylinder engine, 622-3
  - in-line six cylinder engine, 622-3
  - Vee-six cylinder engine, 623-4
  - Vee-eight cylinder engine, 623-4
- exhaust pipe joints, 635-6
- exhaust pipe and silencer support mountings, 634-5
- exhaust stroke, 296, 300
- exhaust system environment, 632
- exhaust system vibration, 634
- expansion tank (radiator), 520-1
  - pressurised, 521
  - vented, 521
- external direct-coupled power assisted steering, 233
- fan-belt pulley to crankshaft attachment, 417
- fan blower, 508-9
- fan discharge control, 509
- fifth-wheel coupling, 7
- field winding excitation, 708-11
- final drive, 14
- final drive gears, 118
- five speed and reverse single-stage constant-mesh gearbox, 51-2
- fixed shackel, 147
- flanged rubber half bushes, 146-7
- flame and induction surface hardening, 421
- flame front spread, 375
- flasher unit, 743
- flat and oveled cam expander, 240-1
- floating cam expander, 240-1
- floating wedge and roller shoe expander, 246
- fluid flywheel, 66-7
- flywheel, 310
- forward control, 4
- force-feed lubrication gearbox, 63
- four speed and reverse double-stage constant-mesh gearbox, 49-50
- four speed and reverse double-stage-sliding mesh gearbox, 47-8
- foot control valve, 282-4
- forced-convection pump circulation, 511-12
- four stroke-cycle compression ignition (diesel) engine, 300-1

- four stroke-cycle spark ignition (petrol) engine, 294-5
- four-wheel-drive, 133-6
- free-wheel, 71
- friction and heat distribution of the piston assembly, 390
- friction clutch, 28
- frictional states, 480
  - kinetic or dynamic, 480-1
  - static, 480-1
  - stick-slip, 480-1
- front-mounted engine and front-wheel-drive, 15, 19
- front-mounted engine and rear-wheel drive, 15, 19
- fuel level variable resistor transmitter, 733, 736, 738, 742
- fuel check-valve, 631, 636
- fuel pipes, 539-40
- fuel tank, 539-40
  - evaporation control, 635, 637
  - filler cap, 636-7
- full-flow oil filter, 492-3
- full-wave bridge circuit rectification for each winding phase, 704, 706-8
- full-wave voltage and current rectification of a three phase alternator, 704
- fully elliptic spring, 142
- fully floating axle hub, 132
- fuse, 655
  - continuous rating, 655
  - current rating, 655
  - rating, 655
- gaskets, 363
  - cylinder head, 364-6
  - tightening, 364-5
- gearbox, 64
  - materials, 366
  - seating conditions, 364
  - sump, 493-4
- gas pressure forces, 341-2
- gearbox, 14, 42
  - dog clutch, 48, 49, 50
  - first motion shaft, 48, 49, 50-8
  - interlocking devices, 55
  - laycluster gears, 48, 49, 50
  - layshaft, 48, 49, 50
  - lubrication, 62
  - main shaft, 48, 49, 50
  - oil leakage prevention, 64
  - oil seals, 64-5
  - primary shaft, 48, 49, 50
  - reverse gear selection, 51
- gear camshaft drive, 433
- gear change lever action, 54
- gear interlocking device, 55
- gear ratios, 42-3
- gear reduction, 42
- gear tooth profile, 45
- gear train, 43
- gears
  - compound gear train, 43-4
  - constant-mesh, 49-50
  - crown-wheel, 120
  - epicyclic, 44-5
  - helical-tooth spur, 46
  - reverse gear train, 44
  - simple gear train, 43
  - sliding-mesh, 47-8
  - spur, 45
  - straight tooth spur, 45
  - annulus, 44-5
  - planet, 44-5
  - sun, 44-5
- generator (dynamo), 700
  - armature, 716-17
  - brushes, 715-17
  - current generation, 717
  - commutation, 716
  - field winding, 717
  - pole pieces, 717
- governor valve (automatic), 92
- governor pressure, 93
- gudgeon-pin, 293, 404-6
- giant balloon tyres, 5
- grid-plate (battery), 695
- gusset bracket, 13
- half or semi-elliptic leaf spring, 142
- half shaft, 129-32
- hall
  - effect, 68-90
  - generator, 689-91
  - integrated circuit and trigger action, 689-3
- halogen gas, 663
- hand brake, 243
  - cable, 252-3
  - lever, 252-4
  - linkage, 251-2
- hand control valve, 284, 286
- hatchback, 1
- hazard warning light, 743, 746
- head light
  - arrangements, 659-60
  - beam settings, 665
  - block-prism lens, 660-1
  - cover lens, 660
  - offset dipped beam, 659
  - offset main and dipped beams, 659
  - offset shielded dipped beam, 659
  - reflectors, 657
  - sealed-beam bi-focal unit, 660
- heat exchanger (oil cooler), 498-9, 515
- helical inlet port, 377
- helical tooth spur gear, 46
- helper springs, 151
- hemispherical combustion chamber, 380
- heterogeneous, 389
- high pressure pump, 499
- high-rate discharge test, 699

- Helmholtz resonator, 627
- Hendrickson long equalisation balance beam tandem axle suspension, 175
- Hooke (Robert), 103
- Hooke's universal joint, 102
- homogeneous fuel mixture, 383-5, 389
- Honda variable timing electronic control (VTEC), 431
- horizontally opposed
  - cylinder blocks, 350-1
  - flat twin cylinder arrangement, 315
  - flat four cylinder arrangement, 317
  - flat six cylinder arrangement, 320
- Hotchkiss drive, 106, 108
- horse power (PS) Germany, 307
- hourglass worm and worm-wheel final-drive, 123
- hydraulic automatic gear change control, 89-91
- hydraulic operated clutch, 39
- hydrocarbon, 625
- hydrodynamic lubrication, 482
- hydrokinetic fluid coupling, 66
- hydrokinetic torque converter-coupling, 70-1
- hydrometer
  - antifreeze, 536
  - electrolyte, 697
- hypoid bevel-tooth gears, 121
  
- inert gas filled bulbs, 656
- inertia-drive starter motor, 720, 722
- inertia reciprocating forces, 341
- induction
  - pulse generator, 685-1, 686
  - semiconductor ignition with basic inductive pulse generator, 685
  - semiconductor ignition with the Hall generator circuit, 689
  - semiconductor ignition with inductive pulse generator, 667
- ignition coil transformer, 670
- ignition delay period (combustion), 373, 384
- ignition distributor, 671
- ignition system
  - electromagnetic induction, 669
  - equipment, 667
  - iron core and sheath, 669, 670
  - operation, 672
  - magnetism, 668
  - mutual induction, 669
  - primary winding and circuit, 667, 670
  - secondary winding and circuit, 667, 670
  - self induction, 669
- ignition timing, 680-1
- ion, 642
- impeller-wheel (fluid drive), 66-7, 69-70
- independent front suspension, 152, 158
  - double transverse-wishbone suspension, 159
  - short swing-arm, 159
  - wheel-hub and swivel-pin (kingpin), 226
- indicated power (i.p.), 307
- indirect injection with swirl type combustion chamber, 388
- indium overlays, 413
- induction and flame surface hardening, 421
- induction wave-ram cylinder charging, 610
- induction spiral swirl, 376
- induction stroke, 294, 300
- inlet and exhaust valve opening and closing periods, 425
- inlet port, 587
- injector unit, 592
  - fuel injection and atomising, 594-5
  - injector spring, 593
  - injector action, 593
  - needle valve, 593
  - nozzle body, 593
  - nozzle holder, 593
  - personal safety precautions when servicing equipment, 595
  - spindle, 393
- in-line crankshaft arrangements
  - side by side twin, 314
  - 180 out-of-phase twin, 314
  - three, 315
  - four, 316
  - five, 318
  - six, 319
  - straight eight, 321
- in-line three cylinder engine balance, 328
- in-line four cylinder engine balance, 329
- in-line diesel fuel injection pump (CAV minimec), 585-6
  - anti-dribble action, 589
  - automatic air bleed, 589
  - control-arm and helix action, 585, 589
  - control-rod operation, 586, 588-9
  - delivery valve action, 588-9
  - output control, 588-9
  - plunger and barrel pumping action, 582-8
  - stop or no-load delivery position, 588-9
  - volume reducer, 589
- inner and outer dead centre (IDC) and (ODC), 293
- inner tubes (tyre), 185
- internal combustion engine, 292
- insulated return (wiring), 644-5
- intake manifold, 559-60
- intercooling (aftercooling), 621-2
- intermediate propeller shaft support bearings, 111
- integral body, 2
- integral power-assisted steering-box, 226, 228-30
- interior heater (cooling), 514-15
- interior heating and ventilation system, 530-1
- inverted semi-elliptic spring tandem-axle suspension, 174
- involute-cam expander, 240-1
  
- jacking points, 24
- jacks
  - bottle, 26
  - cantilever, 25
  - hydraulic, 27

- jib, 25
- scissor, 25
- screw and nut, 25-6
- trolley, 26
- jiggle valve, 517
- jockey wheel pulley tensioner, 438-41
- joule, 643
- journal bearings, 412
  - boundary lubrication, 482
  - frictional resistance oil film thickness and speed, 483-4
  - hydrodynamic lubrication, 482
  - load considerations, 341
  - lubrication, 483
  - materials, 412-13
  - oil pressure distribution, 483-4
  - projected bearing area, 416
  - properties, 412-13
  - scoop-feed lubrication, 484
- judder (clutch), 40
- kick-down cam, 91, 96, 101
- kick-down pressure, 101
- kinetic or dynamic friction, 480
- king-pin
  - fifth wheel, 7
  - steering, 225
- lateral bending (body), 10
- lateral run-out, 201
- layshaft and layshaft cluster gears, 49
- laminated springs, 142
- lead, 626
- lead-acid battery, 694
  - construction, 694
  - container, 694-5
  - discharge, 696
  - discharge and recharge cycle of operation, 696
  - lead (grey spongy lead), 695
  - lead oxide, 695
  - lead sulphate, 696
  - plates, 695
  - plates groups, 695
  - recharge, 696
  - separators, 695
  - simple lead-acid cell, 694
  - terminal posts and lugs, 696
- lead bronze alloy bearings, 413
- lead-indium alloy overlay, 413
- lead-tin based alloy bearing, 413
- lead-tin alloy overlay, 413
- leading and trailing shoe brakes, 237
- leaf springs, 142
- light bulbs
  - capless glass, 661-2
  - double contact small bayonet cap, 661-2
  - festoon, 661-2
  - inert-gas filled, 656
  - miniature centre contact, 661-2
  - miniature Edison screw, 661-2
  - pre-focus double filament, 661-2
  - pre-focus shield double filament, 662-3
  - single contact small bayonet cap, 661-2
  - tungsten-halogen, 662-3
  - vacuum-filled, 656
- light bulb location
  - filament position relative to the focal point, 658-9
  - four head light systems, 665
  - fundamentals, 656
  - head lights, 664
  - location and attachment, 663-4
  - reflectors, 657-8
  - offset dipped beam, 659
  - offset main and dipped beam, 659
  - offset shielded dipped beam, 659
  - parabolic reflector, 657
  - sealed beam bi-focal unit, 660
  - side lights, 663
  - voltage versus bulb light output and life expectancy, 657
- linear reaction control valve steering, 227
- line pressure (automatic), 93
- line-of-stroke, 293
- liquid to liquid oil cooler, 498-9, 515-16
- location of engine and transmission mountings, 346
- load sensing progressive pressure limiting valve, 266-8
- lock-up-clutch, 69, 73
- longitudinal mounted power unit with three or four point support, 345
- longitudinal tensile stresses, 349
- longitudinal torsion (body), 10
- lorry, 5
- lozenging (body), 10
- low oil pressure switch and warning light circuit, 500-1
- lubrication system, 469
  - camshaft bearings, 473
  - camshaft lobe profile, 474
  - connecting-rod
    - big-eng radial-hole spray, 472
    - big-end side clearance spray, 472
    - small-end radial-hole oil spray, 472
  - crankcase fixed-jet oil spray, 473
  - crankshaft oil passages, 478-80
  - cylinder and piston, 472
  - high-mounted camshaft, 474
  - low-mounted camshaft, 474
  - main and big-end bearings, 471
  - main oil gallery, 470
  - oil pressure switch, 469-71, 501
  - overhead camshaft, 477
  - poppet-valves, 475-6
  - rocker-arm mechanism, 476-7
  - small-end, 473
  - timing gear and chain, 478
- lucar connectors, 650, 653
- main-end, 293
- main journals, 414

- main or output shaft, 49
- manifolds
  - coolant circulation heating, 560-1
  - dual stage, 610
  - exhaust, 560
  - induction, 559-60
  - exhaust hot-spot, 560-1
  - pre-heating inunction, 560
  - vacuum advance device, 678
- manual-valve (automatic), 92-3, 97-101
- MacPherson leg-strut, 150, 163-4
- magnesium-silicate ceramic, 627
- magnetic field, 668
  - strength, 668
- magnetic flux, 668
- magnetic lines of force, 668
- magnetism, 668
- magnetic speed sensor or excitor, 274
- magnetic-torque production, 720
- Mashinenfabrik-Augsburg-Nurnberg (MAN), 302
- master cylinder, 236, 258
  - non-residual (Girling), 260
  - residual pressure (Lockheed), 258-1
  - compression barrel (Girling), 260
- mean effective pressure (m.e.p.), 306
- median plane, 114
- mechanical centrifugal advance device, 674-7
- Mercedes twin-spark triple-valve combustion chamber, 381-2
- metal bushes, 146-7
- Metalastik rubber coupling 116
- meters (electrical measurement), 731
- microfarad, 673
- Mitsubishi GDI combustion chamber, 383
- molecules, 64
- mono-cylinder block and crankcase, 349-50
- mono-cylinder head and block, 350
- moving coil meter, 731-3
- moving iron coolant temperature gauge, 734, 735
- moving iron fuel level gauge, 734, 736
- mufflers (silences), 627-32
- multi-carburettors, 560
- multi-coil spring (clutch), 30
- multi-cylinder
  - cyclic torque diagrams, 311
  - engine arrangements, 309
- multi-leaf springs, 145
- multi-meter, 731-3
- multi-taper leaf springs, 146
- multi-way Lucar connectors, 653-4
- multi-plate hydraulic clutch, (automatic), 88
- multi-speed ratio gearbox, 47
- multi-start (worm and worm wheel), 123
- mutual induction, 669
  
- naturally aspirated, 294
- negative temperature coefficient semiconductors, 731, 734
- neutral position (automatic), 95
  
- neutron, 641
- nitriding surface-hardening, 421
- nodular cast iron, 421
- non-reactive bell-crank lever and rod suspension, 174
- non-residual pressure check-valve, 260
- nucleus, 641
- newton, 643
- needle valve (injector), 594
- nozzle (injector), 593
- nozzle holder, 593
  
- Octane number, 375
- off-set gudgeon-pin, 341
- ohm, 643
- oil additives, 504
- oil cooler-liquid to liquid, 498-9, 515
- oil
  - anti-foaming agents, 504
  - anti-wear agents, 504
  - contamination, 505
  - detergents, 504
  - dispersants, 504
  - external contamination, 505
  - internal contamination, 505
  - multi-grade, 502-3
  - pour depressants, 504
  - properties, 501
  - SAE classification, 502
  - sludge, 504-5
  - viscosity, 502
  - viscosity index, 503
- oil filtration, 491-2
  - by-pass flow, 492-3
  - full-flow, 492-3
  - materials, 491
  - replacement periods, 505
- oiliness, 502
- oiliness agents, 504
- oil level check, 504
- oil mist separator, 500
- oil pumps, 484-7
  - drive arrangements, 477-9
  - eccentric bi-rotor
  - external spur gear, 485
  - internal spur gear, 485
  - pressure relief valve control, 489
  - sliding-vane eccentric, 487
- oil pressure switch, 469-71, 498, 500-1
- oil pressure and its distribution, 484
- oil seals
  - crankshaft, 417-18
  - dynamic, 495-7
  - engine, 493-5
  - static, 493-5
  - gearbox, 64
- oil storage tank, 498-9
- one-way clutch, 71
- open circuit, 644, 647
- open deck (cylinder block), 354

Otto Nicolaus August, 294  
ovaled cam expander, 241  
overdrive gearing, 51-3  
overhead camshaft (OHC), 448-51  
    combined sliding bucket and central-pivot rocker, 450  
    end pivot rocker, 450  
    pivot rocker-arm followers, 450  
    single rocker-shaft with central pivot rocker, 450  
    sliding inverted bucket follower, 451  
    twin rocker-shaft with central pivot rocker, 450  
oversteer and understeer, 192-3  
outer dead centre (ODC), 293  
oxidation and corrosion inhibitors, 504  
oxides of nitrogen, 625

Panhard-rod, 168  
pentroof combustion chamber, 380-1  
parabolic reflector, 657  
particulates, 626  
permanent gear reduction, 118  
pick-up van, 2  
pitch circle, 45  
pitch point, 45  
parallel worn and worm-wheel final drive, 123  
perforated tube (silencers), 632  
permanent magnet two pole wiper motor, 746, 748-9  
petrol engine  
    carburation fuel system, 539  
    fuel system layout, 539  
    fuel injection system, 563  
petrol feed pumps, 540  
petrol pump, 541-4  
petrol fuel supply filters, 540  
petrol injection multi-point electronic system, 567  
    air-flow meter, 568, 573  
    air temperature sensor, 568  
    auxiliary air-valve, 568, 575  
    crank angle and speed sensor, 568, 572  
    detonation ignition retardation, 568, 573  
    detonation sensor, 573-4  
    engine management system, 568, 572  
    engine temperature sensor, 573  
    exhaust gas sensor (lambda sensor), 575  
    fast idle control-valve, 568, 575-6  
    fuel injection control, 568, 572  
    fuel system, 568  
    fuel pump, 569  
    ignition timing, 568, 572  
    multi-point fuel injector, 568, 570  
    pressure regulator valve, 568, 570  
    timing  
        sequential injection, 571-2  
        simultaneous injection, 571  
    throttle sensor potentiometer, 573  
petrol injection multi-point (Bosch KE Jetronic) system  
    air flow sensor, 563-4  
    air flow sensor potentiometer, 564  
    accumulator, 563-4

differential pressure-valve, 564-5  
electro-hydraulic pressure actuator, 564-7  
electronic control unit, 567  
fuel injector-valve, 566  
fuel distribution control plunger and barrel  
    operation, 564  
start injector, 564, 567  
throttle-valve switch, 564, 567  
petrol injection single-point electronic system, 576-7  
    fast idle cam device, 577  
    mixture pre-heater, 577-8  
    solenoid controlled control injector unit, 577  
petrol - personal safety precautions, 544  
piston, 292  
piston engine cycles of operation, 292  
piston displacement or swept volume, 305  
piston stroke, 294  
piston  
    bi-metal strut, 395  
    compression height, 395  
    gudgeon-pin boss, 394  
    expansion, 391  
    heat conduction, 391  
    ovality, 395  
    material, 390  
    nomenclature and design, 392  
    ring-belt lands, 392  
    skirt, 393  
    strength and wear, 391  
    taper, 395  
    thermal slots, 394  
    webs, 293  
    weight, 390  
piston and connecting-rod gudgeon-pin joints, 404  
piston and connecting-rod assemblies, 390  
piston ring, 222  
    barrel-faced, 390  
    bevelled scraper, 400  
    blow-by, 499-500  
    chromium-faced, 402  
    chromium-faced plain or inlaid, 399  
    compression ring action, 398  
    composite-rail scraper, 401  
    cylinder wall pressure, 397  
    delayed action double groove scraper, 401  
    diameter, 397  
    double-action stepped scraper, 401  
    externally stepped scraper, 400  
    fitted gap, 397  
    free gap, 397  
    inertia-flow scraper, 401  
    internally stepped, 400  
    joint butting clearance, 403  
    materials, 401  
    oil control ring action, 398  
    oil control rings, 400  
    phosphate-coated, 402  
    plain inlaid, 399  
    stepped and bevelled scraper, 400

- ring-dodger, 400
- radial load and pressure, 398
- radial thickness, 397
- side face, 397
- side clearance, 402
- slotted scraper, 400
- skirt-to-bore clearance, 403
- tangential load, 397
- taper-faced, 399
- types of compression rings, 399
- wedge section, 400
- width, 397
- working force, 397
- working clearances, 402
- upward-run groove, 399
- Platinum, 627
- plunger and barrel pumping action (injection pump), 587-8
- poppet valve, 454
  - dimensions, 454-5
  - heat path and temperature distribution, 454
  - materials, 456-7
  - operating conditions, 455
  - operating mechanism, 442
  - terminology, 460
- positive-baulk-ring synchromesh, 56
- positive castor angle used with rearwheel drive, 155
- positive crankcase ventilation (PVC) system, 499-500
- positive temperature coefficient semiconductors, 731, 734
- potential difference (p.d.), 644
- power, 643
- power diode, 704-7
- power diode functioning check, 714-15
- power window winders, 757-8
  - circuit breaker, 759
  - dual-polarity motor, 759, 761
  - pulley reel and cable mechanism, 759-60
  - sector arm and pinion mechanism, 758-9
  - window switching, 760-1
  - wiring circuit, 760-1
- pour depressants, 504
- planet gear, 44, 126
- plunger and pin interlocking device (gearbox), 56
- pneumatic tyres, 185-92
- pre-engaged starter motor, 722-5
- pre-ignition, 376
- pressure-plate (clutch), 30
- pressure radiator cap, 517-20
- pressure-regulator-valve (automatic), 92
- pressure relief-valve control (engine lubrication), 489-90
- primary valve (dual valve lift), 429-32
- primary
  - couple, 329
  - force, 328
- primary and secondary cells, 694
- primary line fuel filter, 539
- printed circuits, 654
- principal axis, 345
- progressive rate-slipper springs, 143
- projected journal bearing area, 416
- propeller shaft, 14, 102
  - slip-joint, 106
  - vibration, 109
  - whirl, 110
- proton, 641
- primary shaft (input shaft), 48-50, 52
- power (engine), 306
- power assisted steering, 226
- power stroke, 294-5, 300
- push-rod, 444
  - material, 446
- quadruple valve combustion chamber, 381
- quarter elliptic spring, 142
- quartz glass, 663
- quench and squish area, 375, 377
- quick release valve, 287-8
- quiescent quadruple valve combustion chamber, 387
- Quincke Tube, 627
- rack and pinion power assisted steering, 230-2
- rack and pinion steering, 207, 219-22
- radial tyres, 188
- radial run-out, 201
- radiation, 507
- radiator cap
  - pressurised, 517
  - pressure relief valve, 519
  - safety removal device, 519-20
- radiator, 510, 512
  - cross flow, 514
  - vertical down flow, 512
- rapid pressure rise period (uncontrolled combustion), 373, 386
- reactive balance beam tandem axle suspension, 173
- rear axles, 130
- rear independent suspension, 171
- rear mounted engine and rear-wheel drive, 15, 20
- rear suspension, 168
- rebound to bump ratio, 166
- receiver-drier (air conditioning), 534-5
- reciprocating motion, 328
- recirculating ball rack and sector steering box, 223
- rectifier diodes, 704-7, 711
- reflectors
  - deep or shallow, 657
  - parabolic, 657
- release bearing (clutch), 34
- release lever (clutch), 31
- release lever plate (clutch), 30
- removal and replacement of press fit liners, 371-2
- refrigerant, 536
- regenerative or dynamic braking, 752
- relay-valve (brakes), 285, 287
- relative density (specific gravity), 697-8
- resistance (electrical conduction), 643

resistance to motion, 46  
 residual pressure check-valve (brakes), 258  
 residual pipe-line pressure, 588  
 reverse flow (Schnuerle) scavenging, 298  
 reverse gear selection, 51  
 Rhodium, 627  
 rigid axle beam, 148  
 rigid axle beam suspension, 150  
 rigid truck, 5  
 rigid drive-plate (clutch), 33  
 ring and fork plain brass connectors, 650, 653  
 riveted joint, 13  
 road wheels, 179  
 rod and fork gear selectors, 53  
 rod operated clutch, 38  
 Root's rotating lobe supercharger, 616-17  
 rocker-arm, 447  
   materials, 447  
 rocker-shaft, 446-7  
   geometry, 446  
   material, 447  
 roll axis, 158  
 roll centre and roll axis, 157  
 roll centre height, 157  
 roller chains, 436-7  
 roller chain automatic tensioners, 435-6  
 roller chain wear, 437  
 rotary reaction control valve (steering), 231  
 rotor claw pole, 704, 706  
 rotor and winding assembly, 704, 706  
 Rotoflex rubber coupling, 115  
 rubber universal couplings, 115  
 rubber spring tandem axle suspension, 176-7  
 run-flat tyres (Dunlop Denovo), 191  
 Rzeppa principle (CVJ), 114

safety removal device (radiator cap), 519-20  
 saloon car, 1  
 'S' cam expander, 240-1, 280-1  
 scavenging pump, 498  
 scrub radius, 153  
 scavenging (induction and exhaust) phase, 304  
 scoop-feed big-end journal lubrication, 484  
 Scott-Russell linkage, 170  
 seals, 493-7  
 seat belt, 22  
 seat location and securing, 20  
 seat mounting, 20  
 seat rake, 21  
 secondary counter shaft, 337  
 secondary couple (dynamics), 329  
 secondary force (dynamics), 328  
 secondary force balancer, 335  
 secondary line fuel filter, 539  
 secondary-valve (dual stage valve lift), 429-32  
 self ignition temperature, 376  
 selection of plain journal bearing materials, 412-13  
 semi-hydrodynamic lubrication, 482  
 semi-open deep bowl volumetric combustion chamber, 387  
 servo unit (automatic), 90, 91, 93, 97, 98, 99, 100  
 semi-conductor, 684  
 semi-elliptic leaf springs, 141-6  
 semi-floating axle hub, 130  
 semi-trailing-arm rear independent suspension, 171  
 shim-pad tappet adjustment, 451-2  
 shackle arrangements, 146  
 shackle-pin, 147  
 shift-plate, 60-2  
 shift-valves (automatic), 90, 91, 93, 97, 98, 99, 100  
 shoe adjusters, 248  
 short circuit, 647  
 shock-absorber, 148  
 short swing-arm suspension, 150  
 shunt field winding-type wiper motor, 746, 748  
 side member, 4  
 side member bending resistance, 10  
 silent-block rubber bushes, 146  
 silicon aluminium alloy bearings, 413  
 Silicone-fluid, 139, 140  
 silver, 641  
 simple gear train, 43  
 Simpson compound epicyclic gear train, 80  
 single cylinder arrangements, 313  
 single inclined wedge rubber mounts, 346  
 single-line hydraulic braking system, 235  
 single loop alternator, 701  
 single loop dynamo, 715  
 single rail gear selector, 58  
 single-row side-valve combustion chamber (L-head), 377  
 single stage compound epicyclic gear train, 79  
 single stage twin-planet pinion epicyclic gear train, 79  
 single tapered leaf spring, 145  
 single trapezium shaped leaf spring, 145  
 Sir Dugald Clerk, 302  
 slack adjuster, 280  
 sliding-dog clutch, 49  
 slip-angle, 192  
 slip-ring (alternator), 704, 706  
 slip-ring brushes, 704, 706  
 slipper-block contact leaf springs, 143  
 small-end, 293  
 small-end lubrication, 473  
 snap-in bullet connectors, 650, 653  
 Society of Automotive Engineers (SAE)-American, 307  
 solid driven-plate (clutch), 30  
 solid state switch, 684  
 spark ignition combustion process, 373  
 sparking-plug  
   body shell, 683  
   construction, 682  
   electrodes, 683  
   electrode gap, 684  
   fouling, 684  
   insulator, 682

- operating environment, 682
- routine maintenance, 684
- sealing, 683
- size, 683
- speedo-drive, 63
- specific-gravity (relative-density), 697-8
- spider (cross-pin), 126
- spill-port (injection pump), 587-8
- spiral bevel-tooth gears, 121
- spiral thread clearance oil seal, 495-7
- splash-feed lubrication (gear box), 63
- split or dual line braking system, 262
- split commutator (dynamo), 715
- split-ring commutator (wiper motor), 749
- sprag-clutch, 71, 74
- spring beds, 148-9
- spring brake actuator, 280-3
- spring camber, 142
- spring damper, 166
- spring-loaded ball or plunger and selector-rod grooves, 54
- spring saddle, 148-9
- spring shackle, 143
- spring stiffness, 158
- sprung suspension, 141
- spur gear, 45
- squab, 21
- squish or compression swirl, 373
- stainless-steel pipes - catalytic converters and silencers, 633-4
- stall-point (fluid drives), 71
- starter motor, 719
  - armature, 720-1
  - armature recoil device, 728-9
  - axial (sliding armature) type, 725-7
  - brushes, 720-1
  - cable, 730
  - co-axial (sliding-pinion) type, 725, 728-9
  - series-parallel field winding, 727-8
  - field windings, 720-1
  - hold-in winding, 722
  - hold shunt winding, 726-7
  - inertia-drive, 720, 722
  - overload clutch (free-wheel device), 725-7
  - overrun-roller clutch, 724-5
  - overspeed relay, 728-9
  - limiting resistor, 728
  - magnetic torque production, 720
  - main series winding, 726, 728
  - commutation, 720
  - pre-engaged, 722-5
  - pole pieces, 720-1
  - pull-in winding, 722
  - pull series winding, 726-7
  - single loop motor
  - solenoid hold winding, 728
  - solenoid pull winding, 728
  - solenoid switch, 722-3
  - specification, 720-1
  - trip disc, 726, 728
  - trip lever, 726, 728
  - two stage contact switch, 726-9
- static friction, 480
- static ignition timing, 681
- static oil seal, 493-4, 497
- static wheel balance, 199
- stator and winding, 704, 706, 708, 709
- stator blade, 69-72
- stator slots, 708-10
- steering, 14
- steering box, 205, 222-3
- steering system, 203
- stick-slip friction, 480
- Stoichiometric, 227, 625
- straight bevel-tooth gears, 120
- straight tooth spur gear, 45
- stratified fuel mixture, 383-4
- stress distribution in a tightened cylinder-head set screw joint, 358
- stress in leaf springs, 144-6
- striker-bar (door lock), 762
- stub-axle, 206, 223-5
- stud and set-bolt materials, 357
- stud and set-screw threaded cylinder-block holes, 357
- strut and link non-drive rear independent suspension, 172
- Sulzer (gebruder), 302
- sump-pan, 292
- sun gear, 44, 126
- supercharging, 613
  - boost pressure and pressure ratio, 614
  - fundamentals of supercharging, 613-14
  - Root's rotating lobe blower, 616-17
  - screw-type (Sprintex) blower, 616-18
  - sliding-van blower, 614-15
  - turbocharger, 618-21
- sulphuric acid, 694, 697
- support mounting, 15
- suspension, 14
- suspension springs, 141
- swash-plate drive compressor, 533-4
- swing-arm rear independent suspension, 171
- swing shackle, 143, 147
- swivel-(king-)pin inclination, 152, 154
- swivel-pin axis offset, 152
- swivel-pin carrier assembly, 227
- swivel-pin castor angle, 155
- swirl-type combustion chamber (diesel), 388
- synchromesh, 58, 60-2
- taper roller bearings, 131-2
- tappet clearance
  - adjustment for push-rod mechanisms, 447
  - adjustment camshaft positioning for push-rod mechanism, 448
  - adjustment with central pivot, 448
  - adjustment direct acting mechanism, 451
  - adjustment overhead camshaft, 448, 449, 451

- tappet adjustment
  - axial tappet screw, 452
  - shim-pad, 451
  - tappet screw, 452
  - transverse tappet screw, 452
- tandem master-cylinder, 264-6
- tandem-axle leaf-spring suspension, 173
- telescopic shock-absorber damper, 166
- temperature semi-conductor transmitter, 731, 734, 735, 737, 742
- third brush (wiper motor), 749
- third differential, 136-7
- third differential lock, 138
- thermal vane-flasher unit, 743-5
- thermostat housing, 355
- thermostat and by-pass flow control, 514-15
- thermostatic expansion valve, 535-6
- thermo-syphon liquid cooling system, 509-10
- timing
  - belt, 433, 438-9
  - belt tension gauge, 440
  - chain, 433, 436-7
  - gear, 433, 441
- third brush (wiper motor), 749
- three point mounting support, 345
- three-way catalytic-converter, 625, 627
- three-phase alternator, 704
- three-quarter elliptic spring, 141
- three-quarter floating axle hub, 131
- throttle-valve
  - carburation, 546
  - automatic, 92
- throttle pressure (automatic), 92
- thrust springs (clutch), 30
- toe-in or toe-out, 214
- toe-out on turns, 215, 216
- top-dead-centre (TDC), 293
- torque and power, 305-6
- torque converter, 70
- torque converter lock-up clutch, 84
- torque converter relief valve (automatic), 92
- torque-plate (brakes), 280
- torque wrench, 360-1
- torsion-bar double transverse-arm independent front suspension, 161-2
- torsional crankshaft vibration, 335
- torsional crankshaft vibration damper-tuned rubber, 335
- torsional crankshaft vibration damper-viscous fluid, 337
- track alignment and adjustment, 215
- track-rod, 206
- track-rod ball joints, 218
- traction control system (TCS), 275-6
- trailing-arms, 168
- trailing-arm rear independent suspension, 171
- trailing-arm torsion-bar rear independent suspension, 172
- tractive effort, 46
- trammel wheel-track alignment gauge, 217
- transaxle automatic transmission, 82-4
- transmitters (temperature and fuel), 731, 733, 734
- transverse double wishbone suspension, 150
- transverse mounted power unit with three point support, 345
- transverse mounted semi-elliptic spring, 142
- transistors, 684-5
- tri-axle, 2
- true-rolling, 209
- Tungsten-halogen bulb, 662-3
- turbine-wheel, 66 (fluid-drive), (supercharging), 690
- turbocharger, 614-15
- turbulence, 377
- tumble barrel-roll swirl, 376
- turn-table, 7
- turn-table steering, 209
- triple-valve pentroof combustion chamber, 380
- twin countershaft secondary balancer, 335-7
- twin spark triple-valve combustion chamber, 381-2
- twin cylinder crankshaft arrangement, 314-15
- twin cylinder engine balance, 330
- twin planet pinion epicyclic gear train, 79
- twist axle beam, 169
- two speed
  - and intermittent windscreen wiper system, 754-7
  - field winding wiper motor, 746, 748
  - permanent magnet wiper motor, 746, 748, 750-2
  - wiper with cam operated limiting and braking switch, 752
  - wiper with slip-ring reed contact limiting and braking switch, 753-4
- two-stroke cycle diesel engine, 302-3
- two-stroke cycle petrol engine, 296-7
- tyres
  - aspect-ratio, 181
  - comparison of cross-ply and radial-ply characteristics, 189
  - cross-ply, 188
  - inflation pressure, 197
  - inner tubes, 185
  - legal and technical requirements, 192
  - oversteer and understeer characteristics, 192-3
  - radial-ply, 188
  - run-flat tyre, 191
  - size and designations, 193-4
  - slip-angle, 192
  - speed markings, 194
  - tread wear, 193
  - tubeless, 187
  - valves, 194-6
- 'U' bolts, 148-9
- understanding gear ratios, 42
- understeer and oversteer characteristics, 192-3
- unloader-valve (pressure regulator), 282-4
- universal joints, 102
  - constant-velocity, 102, 109
  - constant velocity joints, 114

- divided propeller shafts and their support, 111-12
- doughnut (Rotoflex) rubber coupling, 115-16
- grease seals, 105-6
- Hook's joint, 102-3
- Layrub bush (Metalastik) coupling, 116
- lubrication, 104
- needle-race bearing, 104
- rubber couplings, 115
- propeller-shaft, 102
- propeller-shaft vibration, 109
- series coupled joints, 108
- slip-joint alignment, 106, 113
- speed variation, 104
- trunnion cross or spider, 104
- yokes, 102
- unsprung mass, 158
  
- vacuum advance device, 678-80
- vacuum assisted brake servo unit, 268
- vacuum-filled bulbs, 656
- vacuum relief-valve (radiator), 519
- vapour compression refrigerator cycle, 537-8
- valve automatic tappet clearance take-up, 463-8
  - compensation with central pivot rocker-arm and hydraulic follower, 465-6
  - compensation with direct acting inverted bucket follower, 465, 467-8
  - compensation with end pivot rocker-arm hydraulic pivot post, 463-4
- valve actuating
  - gear requirements and consideration, 452
  - mechanism
    - advantages and disadvantages of different arrangements, 453
- valve (poppet)
  - collets, 460
  - collet and spring retainer, 459-60
  - considerations, 456
  - double springs, 460
  - function and arrangement, 442
  - guides, 457
  - head loading, 456
  - materials, 456-7
  - positive valve-rotation (Rotocap), 460-1
  - requirements, 456
  - return springs, 461
  - seat conical angles, 455
  - seat insert rings, 458
  - seat inset material, 459
  - split-collet valve-rotator, 459-60
  - spring materials, 463
  - spring pre-stressing, 462
  - spring shot peening, 463
  - spring surge, 462
  - stem, tip, head and neck operating conditions, 455
  - thimble valve-rotator, 460
  - valve stem oil seal, 464, 466
  - variable pitch springs, 461-2
- valve closing period, 427
- valve lag, 296, 425
- valve lead, 296, 425
- valve opening period, 427
- valve overlap, 296, 425-6
- valve timing diagrams, 296, 425-6
- valve variable lift and opening periods, 429-32
- van, 8
- vee-banked cylinder blocks, 351-3
- vee-cylinder arrangements
  - twin, 322
  - four, 323
  - six, 324
- eight with single-plane crankshaft, 325
- eight with two-plane crankshaft, 326
- vee-cylinder engine balance
  - twin, 330
  - six, 332
  - eight, 332
- vertical bending, 9
- vertical down-flow pump assisted liquid cooling system, 512
- viscosity, 502
- viscosity index, 503
- viscosity coupling (transmission), 139-40
- viscous fan coupling, 527
- viscous-fluid torsional vibration damper, 337
- volumetric efficiency, 426
- voltage, 643
- voltage-drop, 644
- voltage regulator
  - alternator, 712-14
  - dynamo, 718
    - current control, 718
    - cutout, 716
    - voltage control, 718
  - functioning check, 715
- voltage stabilisers
  - bi-metal thermal type, 738-9
  - Zener diode type, 739-40
  
- wastegate, 620-2
- water hose, 510
- Watt, 643
- Watts-linkage, 168-9
- wave-ram cylinder charging, 610
- wax thermostat, 516-17
- welded joint, 13
- wedge-type combustion chamber, 379
- wet cylinder liners, 369
- wet sump lubrication system, 470
- wheel, 179
  - alignment, 213-15
  - alloy types, 183
  - balance, 197, 199-202
  - camber-angle, 152
  - bearing-hub assembly, 223, 225
  - construction, 179-85
  - mountings and fixtures, 179
  - cylinder, (brake) 236

pressed-steel disc wheel, 179  
refitting, 196  
removal, 196  
rims, 181  
    examination, 196  
structure, 17  
stud and nut fixtures, 183-4  
tyre attachment, 179  
weight, 179  
wheel-base, 5  
wheel-track, 5  
white (Babbit) metal bearings, 413  
Wilson compound epicyclic gear train, 82  
windscreen wiper

drive mechanism, 749-50  
linkage geometry, 751  
system, 746  
two-speed motor with cam-operated limiting and  
    brake switch, 752  
two-speed motor with slip-ring reed contact limiting  
    and brake switch, 753  
two-speed motor and intermittent wiper system,  
    754-7  
woodruff-key, 417  
wiring circuit for power-windows, 760-2  
worm and worm-wheel gears, 122  
  
Zener-type doide, 688, 692, 712-13, 740, 747